Samia fulva JORDAN, 1911 from the Andaman Islands, India (Indian Ocean) — preimaginal instars, host plants and taxonomical notes (Lepidoptera: Saturniidae)

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Abstract: The immature stages and the larval hostplants of *Samia fulva* JORDAN, 1911, **stat. nov.** as species, the only so far known representative of the genus on the Andaman Islands, are for the first time described and illustrated in colour. The complete life cycle of the moth has also been worked out for the first time. Notes on the known foodplants and parasites of this species are given. Due to the differences to other species of the genus *Samia* [HÜBNER, 1819] in the imago and in preimaginal instars, which derived from the long isolation of the Andaman Islands from both mainland of Asia and Sumatra, we raise this endemic species to full species rank. The male lectotype of *Samia fulva* is **designated**.

Key words: Andaman Islands, *Samia fulva*, new status, Saturniidae, behaviour, oviposition, phenology, preimaginal instars.

Samia fulva JORDAN, 1911 von den Andamanen, Indien — Präimaginalstadien und Futterpflanzen sowie taxonomische Bemerkungen (Lepidoptera: Saturniidae)

Zusammenfassung: *Samia fulva* JORDAN, 1911, **stat. nov.** als separate Art, wurde ursprünglich als Unterart *Samia lunula fulva* von Port Blair, Andamanen, beschrieben. Schon aufgrund der eigenständigen äußeren Merkmale des Falters und der ♂ Genitalmorphologie sollte dem Taxon im Rahmen der Gattungsrevision (PEIGLER & NAUMANN, in Vorbereitung) Artrang eingeräumt werden; auch die lange Isolation der Inselgruppe vom südostasiatischen Festland und von Sumatra sprachen hierfür, weswegen bereits PEIGLER (1989) den endemischen *Attacus mcmulleni* (WATSON, 1914) auf Artrang erhob; weitere Autoren folgten diesem mit anderen Endemiten von den Andamanen (NÄSSIG 1989, PRASHANTH MOHANRAJ et al. [1996], VEENAKUMARI et al. 1996). *S. fulva* wurde von JORDAN nach einer Serie von einem ♂ und vier ♀♀ Syntypen beschrieben, die komplett im Natural History Museum (BMNH) in London vorliegen; aus dieser Serie **designieren** wir den ♂ Falter als **Lectotypus**; die vier ♀♀ werden damit zu Paralectotypen. Entsprechende Etiketten werden an den Faltern angebracht.

Nach Beiträgen zur Biologie von *Attacus mcmulleni*, *Actias callandra* JORDAN, 1911 und *Cricula andamanica* JORDAN, 1909 (VEENAKUMARI et al. [1995], 1996, PRASHANTH MOHANRAJ et al. [1996]) werden hier die Präimaginalstadien der an-

damanisch-endemischen *S. fulva* beschrieben. Die Eier sind weiß und werden, wie auch von anderen *Samia*-Arten bekannt, in asymetrisch dreiecksförmigen Wänden, die aus mehreren Reihen übereinanderliegender Eier, insgesamt aus ca. 30 bis 75 Stück, bestehen, auf der Blattunterseite abgelegt. Vom ersten bis vierten Stadium leben die Raupen gesellig, im fünften, letzten Stadium verteilen sich die Raupen auf die Futterpflanze. Im ersten Stadium ist die Raupe gelb mit schwarzen Scoli, Zeichnungselementen und Kopfkapsel. Im zweiten Stadium besteht weiterhin eine gelbe Grundfarbe mit schwarzer Zeichnung, auch die Beine sind nun schwarz; auch im dritten Larvalstadium ist die Grundfarbe gelb mit scharzen Zeichnungselementen und Kopf, die lateralen Scoli sind schwarz, während die dorsalen und subdorsalen Scoli hellgelb sind. Ab dem vierten Stadium ist der Kopf gelb mit hellblauer Maxille und Labrum; die Grundfarbe ist nun weißlichgrün, die Scoli in der Grundfarbe mit etwas Wachsbesatz. Im Bereich der gelblichen Analplatte türkise Umrandungslinien und Scoli. Im fünften, letzten Kleid ist die Raupe hellgrün, die Füße und der Nachschieber sind gelblich. Die dorsalen Scoli sind jetzt auffällig rotorange gefärbt und zum Körper hin türkis abgesetzt, die subdorsalen Scoli nur rotorange. Subdorsal liegen auf jedem Segment zwei schwarze, kleine Flecken. Die lateralen Scoli schließlich sind fast komplett türkisblau mit einer kleinen roten Spitze, auf den Thorakalsegmenten ist jeweils noch ein hellblauer subdorsaler Scolus vorhanden. Die Raupe von *Samia fulva* unterscheidet sich zumindest in den letzten beiden Stadien deutlich von allen anderen bekannten Raupen der Gattung *Samia* durch die rotorange und türkise Musterung sowie die Ausprägung der schwarzen Zeichnungselemente; vergleichende Untersuchungen zu den ersten Stadien stehen noch aus. Kokon und Puppen sind typisch für die Gattung *Samia:* Der Kokon ist spindelförmig und zweiwandig und wird zum Schutz vor Herabfallen mit einem Fortsatz um den Blattansatz und Zweig herumgesponnen. Die braune Puppe ist am Kremaster nicht mit Borsten versehen und ist am Abdominalende nicht im Kokon verankert. Es werden erstmals sämtliche Stadien der Art abgebildet. Als Futterpflanzen auf den Andamanen wurden *Heteropanax fragrans* (Araliaceae) sowie *Zanthoxylum rhetsa* (Rutaceae) festgestellt; außerdem wurden Kokons auf *Picrasama javanica* (Simaroubaceae) gefunden, die wahrscheinlich ebenfalls eine Futterpflanze darstellt. *Zanthoxylum* und *Picrasama* wurden bisher noch nicht als Futterpflanze für die Gattung *Samia* beschrieben (Stone 1991).

Introduction

Samia fulva was described as an endemic subspecies from Port Blair on the island of South Andaman, from a short series comprising 1 ♂ and 4 ♀♀, as *Samia lunula fulva* by Jordan (1911). While elevating *Attacus atlas mcmulleni* Watson, 1914 to a full species, Peigler (1989: 78) emphasized that the taxon *fulva* differed sufficiently in appearance from related mainland taxa meriting retention as a distinct subspecies. He was also of

the opinion that more detailed studies of the three at that time known endemic subspecies of these islands – *S. cynthia* [sic] *fulva* JORDAN, *Actias selene callandra* JORDAN, 1911 and *Cricula trifenestrata andamanica* JORDAN, 1909 – may result in their elevation to full species status. Subsequent studies on *A. callandra* (PRASHANTH MOHANRAJ et al. 1993 [1996]) and *C. andamanica* (NÄSSIG 1989, VEENAKUMARI et al. 1996) did result in the discovery of characters that validated PEIGLER's earlier opinion. We now report the results of a study on the larval foodplants, life history and preimaginal stages of *S. fulva* for the first time. Due to the differences of the early instars to other members of the genus, and also due to the well distinguishable wing pattern and male genitalia structures, we raise *S. fulva* to full species rank **(stat. nov.)**, prior to the revision of the genus which is in preparation by PEIGLER & NAUMANN.

From the type series of *Samia lunula fulva,* which still is kept in The Natural History Museum (BMNH) in London we hereby **designate** the single male as **lectotype;** the 4 ♀♀ thereby become paralectotypes. A lectotype label will be added accordingly.

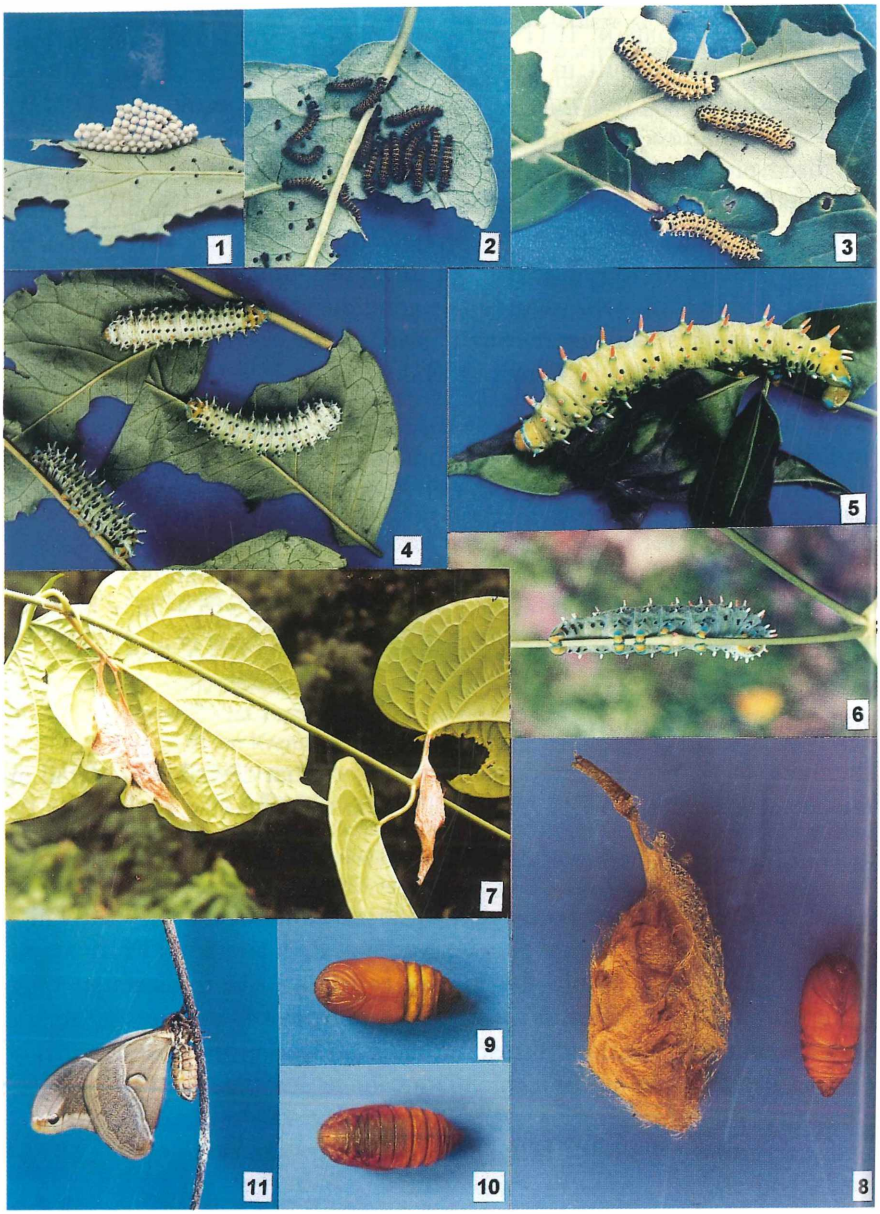
Background information on the Andaman and Nicobar Islands – location, number of islands, tectonic history, vegetation types, etc. – may be seen in PRASHANTH MOHANRAJ et al. ([1996]) and VEENAKUMARI et al. (1996).

Materials and methods

The methods that we followed were identical to that described in detail in VEENAKUMARI et al. ([1995], 1996) and PRASHANTH MOHANRAJ et al. ([1996]).

Site characteristics

We (P.M., K.V.) collected both eggs and larvae along with their hostplants and cocoons from the Mount Harriet National Park and from Chiriyatapu on South Andaman. While the former collecting site is dominated by evergreen forests, the latter is mostly covered by mixed deciduous forests. Both are, however, lowland forests situated on terrain that rises from sea level to a maximum altitude of 365 m above sea level at Mt. Harriet. While the site at Mt. Harriet is a primary forest with some degree of human interference, that at Chiriyatapu is a composite of primary and secondary forest.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Colour plate 1: *Samia fulva*. **Fig. 1:** Eggs, oviposited in the projecting "wall" typical for *Samia*. Fig. 2: L. larvae. **Fig. 3:** L_2 larva (centre), L_3 larvae (top and bottom). **Fig. 4:** L_4 larvae. **Figs. 5, 6:** L_5 larvae; Fig. 5 lateral view, Fig. 6 ventral view. **Fig. 7, 8:** Cocoons; Fig. 7 naturally within the foodplant, Fig. 8 separate, with pupa. **Figs. 9, 10:** Pupae, Fig. 9 ventral, Fig. 10 dorsal view. **Fig. 11:** Adult ♀.

Colour plate 2: **Fig. 12**: Plant of *Heteropanax fragrans* (Araliaceae) extensively defoliated by a brood of *Samia fulva*. **Fig. 13:** A field assistant high up in a tree of *H. fragrans* collecting larvae and cocoons of *S. fulva*. **Fig. 14:** Adult ♀.

Results

Larval foodplants and behaviour

The moth was successfully reared to adulthood on the leaves of *Heteropanax fragrans* (Roxb.) Seem (Araliaceae) and *Zanthoxylum rhetsa* (Roxb.) DC. (Rutaceae) in the laboratory. Larvae were also observed to complete their life cycles on these two hosts successfully under natural conditions at Mt. Harriet. We suspect that *Picrasama javanica* Blume (Simaroubaceae) is possibly an additional larval foodplant as we obtained more than 20 cocoons of *S. fulva* on the leaves of this plant at Chiriyatapu. Incidentally two eggs and one cocoon of *Attacus mcmulleni* were also collected on the same plant. This therefore is probably an additional larval foodplant of *A. mcmulleni*, too.

The larvae were gregarious up to the fourth instar and then dispersed in the fifth, final instar. In the field it was observed that in the fifth instar larvae did not stay together on one leaf; they confined themselves to the foliage of a single tree.

Life cycle and phenology

In the laboratory, *S. fulva* completed its life cycle in 46-62 days (Table 1). There was a progressive increase in the number of days taken to complete each preimaginal stage with the pupal duration being significantly longer than any of the other stages. The first four instars were gregarious in the laboratory. The last instar was reared in smaller groups of 2-6 individuals depending on the size of the container.

Table 1: Duration and dimensions of the immature stages of *Samia fulva* on the island of South Andaman.

	Egg	Larval instars					Pupa	Total
		L_1	L_2	L_3	L_4	L_5		
Duration								
Days	4	3	3-8	5-7	6-7	5-9	20-24	46-62
n	7	79	19	12	10	13	13	
Dimensions [cm]							Pupa	
n	–	15	14	12	22	20	11	
Mean	–	0.53	1.20	1.66	2.81	4.26	4.59 × 2.04	
Range	–	0.5-0.6	1.0-1.3	1.6-1.7	2.5-3.2	4.0-4.7	4.0-4.9 × 1.7-2.4	
± S. D.	–	0.05	0.11	0.05	0.23	0.23	0.26 × 0.17	

The eggs and larvae of the moth were found at Mt. Harriet and Chiriyatapu in July, August and September. Two adult moths were found in the forenoon resting with wings folded on the undersurfaces of leaves about 1.5 m above the ground on 28. VI. 1996 at Chiriyatapu.

Description of immature stages

Eggs (Fig. 1): The white eggs are laid in groups of 30 to 75 on the undersides of leaves. They are stacked in tiers beneeth each other to form a triangular "wall" vertical to the leaf surface, with the base of the triangle being in contact with the leaf. The number of the eggs in each tier of that egg mass with 75 eggs was as follows: tier I: 16 eggs; tier II: 14 eggs; tier III: 15 eggs; tier IV: 12 eggs; tier V: 7 eggs; tier VI: 5 eggs; tier VII: 5 eggs; tier VIII: 1 egg. The eggs were laid evenly spaced, in regular arrangement in the basal three tiers while they were arranged more assymetrical in the upper tiers. Another egg mass collected in August from Chiriyatapu was found on the underside of a leaf. Its eggs were arranged as follows: tier I: 9 eggs; tier II: 8 eggs; tier III: 7 eggs; tier IV: 4 eggs; tier V: 2 eggs. This stack of eggs had two peaks and was in the form of 2 conjoined, confluent triangles. All the 4 egg stacks that we collected from Mt. Harriet and Chiriyatapu were found to be deposited on the undersides of leaves. The bases of each stack were always parallel to the midrib and the majority of the eggs had their micropylar ends facing to the leaf edge.

A female collected on 26. VII. 1992 was confined in a cage into which we placed a bouquet of *Lagerstroemia hypoleuca* KURZ (Lythraceae) leaves. We chose *Lagerstroemia* as we did not know the larval hostplant of *S. fulva* at that time, and it was the most easily available of the larval hostplants for the genus *Samia* listed by STONE (1991). The next day we found 2 irregular egg masses, one containing 15 eggs while the other consisted of 37 eggs. The eggs were dirty white in colour with short projections distributed tiniformously over the surface giving it a jackfruit like appearance. The single egg was elliptic in outline and some of them had sparsely distributed long brown hairs adhering to their surfaces. On the second day the same female laid eggs in two masses of 64 and 82 eggs each. This time the freshly laid eggs were rich cream in colour. One egg was also laid singly with one of its narrow ends adhering to the leaf surface. A total of 199 eggs were laid by this female in two days.

Since the first instar larvae did not feed on *Lagerstroemia* we tried a number of other leaves: *Syzygium* sp. (Myrtaceae), *Cinnamomum* sp. (Lau-

raceae), *Crypteronia paniculata* BLUME (Crypteroniaceae), *Averrhoa bilimbi* L. (Averrhoaceae), *Mussaenda* sp. (Rubiaceae), *Artocarpus chaplasha* ROXB. (Moraceae), *Rosa* sp. (Rosaceae), *Jatropha* sp. (Euphorbiaceae), *Vitex trifolia* L. (Verbenaceae), *Annona* sp. (Annonaceae) and *Ceiba pentandra* var. *indica* (DC.) BAKH. (Bombacaceae). The larvae rejected all these leaves as food and died.

Table 2: Head capsule width of the first four instars of *Samia fulva*.

	Larval instars			
	L_1	L_2	L_3	L_4
n	13	22	17	12
Mean [mm]	0.9	1.45	2.1	3.2
Range	–	1.4-1.5	2.0-2.2	3.1-3.3
± S. D.	–	0.05	0.07	0.05

First instar (Fig. 2): Head, prothoracic shield, legs and anal plate are glossy black in colour. The head has black setae. The labrum, labium and maxillae, are all dirty white to cream in colour. The dorsal and lateral surfaces of the body are coloured intensive yellow, while the intersegmental regions, the ventral surface and the prolegs are paler. A pale black horizontal band is present on the prolegs. The dorsal, subdorsal and lateral scoli are all black in colour with four black terminal setae on each. A series of alternating black triangles and spots forms a mid-dorsal band. The triangle has its base parallel to the anterior margin of each segment and its apex pointing towards the centrally placed spot on each segment. Each segment has an additional pair of anterior and posterior irregular black spots between dorsal and subdorsal and between subdorsal and lateral scoli. The eighth abdominal segment bears one mid-dorsal scolus, 2 subdorsal scoli and 2 lateral scoli.

Second instar (Fig. 3, centre): Larva in yellow ground colour with glossy black head. The labrum, labium, clypeus, maxilla and palps are all yellow. The prothoracic shield is also yellow with a broad glossy black band posterior which is discontinuous at the centre. The dorsal, subdorsal and lateral scoli are black with dirty white setae. The thoracic segments have an additional set of subventral scoli. Between the dorsal scoli, there is a mid-dorsal row of nearby circular black spots – one anteriorly and one posteriorly situated on each segment except on the prothorax where these spots are absent. There is a similar line of black spots between the subdorsal and lateral scoli. The only black spot on the prothorax is a small one, an-

terior to, and a little above the spiracle. All spiracles are black in colour. The legs are black while the prolegs are yellow with a basal black band (which is glossy on the anal prolegs) and brown crotchets. The ventral surface is pale yellow, the anal plate is black.

Third instar (Fig. 3, top and bottom): Freshly moulted third instar larvae are fully yellow (inclusive of the head capsule and the scoli) with prominent black spots. Later, the head, the anal plate, and sides and rear of the anal prolegs turn glossy black. The spiracles and legs are also black, but the prolegs remain yellow developing a broad lateral black band. The dorsal and subdorsal scoli are yellow with yellowish setae while the lateral scoli are deep, glossy black with black setae. The middorsal scoli on abdominal segment 8 are fully fused; the scoli are either entirely blue or terminally yellow. The pattern of black spots is similar to that of the second instar but the dorsal and subdorsal scoli are separated by a greater distance. There is some, but minor, production of wax on the body, but much less intensive than in most other species of *Samia* where the larvae are known.

Fourth instar (Fig. 4): Head yellow, labrum and maxillae pale bluish green; legs and prolegs yellow, crotchets brown. The body and the scoli are largely ashy-white. The scoli have a few short, black setae and are tipped with little waxy material. The surface of the body is smooth with no waxy coating. Spiracles are velvet black in appearance. The prothoracic shield is faint yellow towards the posterior end and there is a pit on each side of the shield. Anal plate with pale blue lateral lines and the two rear scoli on anal plate very pale blue in colour. The anal prolegs are dabbed with blue distally. Short black setae are present on the yellow surface of the prolegs.

Fifth instar (Figs. 5, 6): The larva appears now in pale green colour with yellow head and pale blue labium and maxillae. The legs and prolegs are yellow with black claws and brown crotchets, respectively, and with intensively turquoise basal band on the outer surface of the prolegs. The prothoracic shield is yellow, the anal plate is pale yellow with turquoise margins. Spiracles are black. There is one black spot anterior to and two black spots posterior to each spiracle. Dorsal scoli are reddish orange with a narrow pale blue band on their base. Subdorsal scoli are very pale orange, otherwise they are identical to the dorsal scoli in colour. There are two irregular, black spots on each segment in the space between the dorsal and subdorsal scoli – one anterior and one posterior to the line

joining the two scoli on each segment. Both dorsal and subdorsal scoli are reduced to small, wart-like projections. Lateral scoli are tipped with pale orange, but the blue patch covers a relatively greater area. The thoracic segments in this instar have small but prominent, pale blue lateroventral scoli with a black ring at the base of each scolus. The single middorsal scolus on the eighth abdominal segment is of a bright reddish orange with again a pale blue base.

Cocoon (Figs. 7, 8): The cocoon is spindle-shaped with a pale brown exterior as typical for the genus. The inside of the cocoon is paler in colour and smooth. A papery thin layer of silk anchors it to the lamina of the leaf with silk from one end being wound around the petiole and twig thus securely anchoring the cocoon. The mean weight of an empty cocoon (from which adult moths had emerged) was 0.71 g (n = 6, ± S.D. 0.007). The exuviae and head capsules of the last instars are loosely attached to the anal end of the pupa within the cocoon.

Pupa (Figs. 8, 9, 10): The short, stubby pupa is not anchored within the cocoon with its cremaster and can easily be removed when the cocoon is cut open. It is brown with a brown dorsum and a yellow suffusion on the wing pads. There is a irregular, darker brown dorsal area from the head to the third abdominal segment. The ventral surface of the abdominal segments is yellowish. The spiracles are deep brown with a black longitudinal stripe in the centre. Above each spiracle is a small projection, these become progressively larger from anterior to posterior forming a line parallel to the spiracular line. A pair of papillae are present on each side of the mid-ventral line of the fourth and fifth abdominal segment, with the latter ones being more strongly developed than those on the former. The pupa is capable of rotating its abdominal segments vigorously from the fourth segment (i.e., from below the apex of the wing pads) onwards. Small wart-like projections which are not hooked constitute the cremaster. The dorsal projections are more developed than those lower down.

A single pupa was found about 6 m high on a wild nutmeg tree (Myristicaceae: *Myristica* sp.) at Mount Harriet.

Parasites: While rearing field collected specimens in the laboratory we found some eggs which had been parasitised by *Telenomus (Aholcus)* sp. (Hymenoptera: Scelionidae) (IIE identification no. 1792) while a large unidentified species of *Xanthopimpla* (Hymenoptera: Ichneumonidae) was a pupal parasitoid.

Discussion

The genus *Samia* comprises of a group of Oriental species which can be found from the NW Himalaya in the West to the Moluccas in the East, and from Japan in the North to Timor Island in the South, plus some introduced populations in other non-Oriental countries. Much confusion still persists with the correct application of names especially for the Asian mainland species (PEIGLER 1992), and a taxonomic revision with inclusion of all type specimens and names proposed so far is in preparation (PEIGLER & NAUMANN).

So far, of most *Samia* species the life cycles have not yet been described, and differences mainly were worked out by study of the external and genitalia morphology, although the sometimes much more differentiated characters of larval morphology can often be very useful to clarify taxonomical status problems of nearly related taxa (LAMPE 1985, VEENAKUMARI et al. 1996). From genitalia studies, it became clear that *S. fulva* is a close relative of the Himalayan *S. canningi* HUTTON, 1859 with which it shares nearly all typical structures as the form of the bilobed valva and the broad saccus, but not the quite short aedoeagus. Due to the relatively similar wing pattern, and not to the at this time not studied genitalia morphology, BOUVIER (1936) cited both species in a "*canningi*-group". Unfortunately, for the relatively well-known *S. canningi* the lifecycle is not reported completely so far, and in recent literature only single adult or subadult larvae of this species were figured (PINRATANA & LAMPE 1990: a larva is figured very well, but shows a surprisingly large wax production; ALLEN 1993). Nevertheless, in both publications a larva of the same species was figured which clearly differs from the larva of *S. fulva* by the missing of any red and most turquoise pattern. The last instar larva of the *Samia insularis*-group representative from nearby Sumatra Island looks totally different, without any red and turquoise colours and much more black pattern (NÄSSIG et al. 1996). All these mentioned differences both in larva and in imago, and the long lasting isolation of the Andaman Islands from mainland of Asia lead us to the view that *S. fulva* should be given full species rank.

50 plant species belonging to 41 genera and 30 families are listed as larval foodplants of three species of the genus *Samia* (STONE 1991). Here, however, for the first time the larval foodplants of *S. fulva* are reported. On family and generic levels we have found no novelties among the foodplants; at least, *Zanthoxylum rhetsa* is a new foodplant record for the ge-

nus, and if *Picrasama javanica* is confirmed to be a foodplant it will be the first time that this genus is being reported to be utilised as food by the larvae of a *Samia* species (compare STONE 1991). The way of egg deposition in rows projecting from the leaves (like a "wall") as observed in *S. fulva* is typical for the genus: NÄSSIG et al. (1996: 143) figured an egg cluster from Sumatra, and also for other species this is known (S.N. pers. obs.).

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